

Cutsforth

ROLE OF EMOTION IN A SYNAESTHETIC SUBJECT.

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THE RÔLE OF EMOTION IN A SYNAESTHETIC SUBJECT

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The work of Wheeler and Cutsforth on synaesthesia has apparently tapped so many problems, not only in synaesthesia, but in general psychology as well, that it seems expedient to present certain details of another case. This case has been selected especially for the light it throws upon the content of emotion and the relationship between the so-called feeling and cognitive processes.

It will be remembered that synaesthesia as described in earlier articles¹ is unquestionably a process of perceiving. If this is true, it seemed to the writer that a study of synaesthetic processes in the field of emotion would prove enlightening; for it was suspected that the conventional distinction between feeling and cognition failed to hold in synaesthetic Ss. Neither the view that feelings evaluate while perception furnishes knowledge, nor the view that feeling and cognition are two aspects of the same consciousness, seemed valid in face of our preliminary investigations. Moreover, our results of more recent date brought us in touch with the problem of the stimulus error, and unquestionably threw this problem into line with our discovery of the "parent process." Meanwhile, we were still concerned with the problem of meaning.

We shall here attempt to present the facts of a particular case. It will be observed, no doubt, that our use of words presenting the reports of our *S* does not harmonize in many respects with their ordinary psychological usage. The reasons for this departure should become apparent as we proceed.

The *S* for this investigation was Miss *E*, a graduate student in the University of Oregon, a 'major' in education, but well trained in psychological procedure. Our methods in this experimentation were so varied that they will be presented in connection with results throughout the paper.

When about 9 years of age *E* became aware of her synaesthetic processes, but of course did not recognize them as such. Recognition came about

¹R. H. Wheeler, Visual phenomena in the dreams of a blind subject, *Psychol. Rev.*, 27, 1920, 313-322; The synaesthesia of a blind subject, *Univ. of Ore. Publs.*, 1, No. 5, 1920, 61pp.; Wheeler and Cutsforth, The synaesthesia of a blind subject with comparative data from an asynaesthetic blind subject, *ibid.*, 1, No. 10, 1922, 104pp.; The rôle of synaesthesia in learning, *Jour. Exper. Psychol.*, 4, 1921, 448-468; Synaesthesia and meaning, this JOURNAL, 33, 1922, 361-384; Synaesthesia, a form of perception, *Psychol. Rev.*, 29, 1922, 212-220; Cutsforth, The rôle of synaesthesia in reasoning, this JOURNAL 35, 1924, 88-97.

through a chance discussion with a group of older girls concerning the nature of piano tones. Soon she discovered that her thinking differed markedly from that of other girls. Until she reached her senior year in college and began to act as *S* in the psychological laboratory she suffered from the misapprehension that her mental life was abnormal. Throughout this long period she made repeated efforts to avoid the use of colors in her sensory and emotional experiences; but the attempt to eradicate the visual processes was a failure, and the only result was a modification in the behavior of the imagery and a possible reduction in her mental efficiency. *E* has now been under observation for 18 months.

A typical childhood memory. Our procedure here was simple. *E* was asked to recall several of her earliest memories and then to give a complete introspective account of her mental processes. Space will not permit a publication of detailed introspective data.

In summary, *E*'s childhood experiences are recalled in terms of concrete visual and synaesthetic visual imagery. The concrete imagery appears in fragmentary form, visualized through a washed-out film of synaesthetic coloring which has been retained as the content of an emotional experience. For example, *E* recalls that when about 5 years of age she was in the middle of a fully-bloomed clover field. The red and green of the clover appear to her now in quite definite visual imagery; projected through and upon the concrete visual imagery is a gauzy film of bright rose. This, she reports, is the synaesthetic color of joy which she experienced at the time. The rose-color is not directly associated with the clover blossoms, for it is of different tint and has the full significance of an emotional experience. In fact, the rose-synaesthesia is the reduced or mechanized content of the emotion itself. In recalled, as in immediate emotions, details such as intensity, affective quality and interpreted meaning consist exclusively of synaesthetic coloration, from the standpoint of sensory content.

E's stereotyped image-forms. *E* makes constant use of schematized forms in computing numbers, in reckoning the days of the week and months of the year, also in recalling the alphabet. These forms are rich in emotional coloration, traceable to the affective color-reactions of early childhood. This coloration assumes in part the concrete hue, shape, position and behavior of early visual associations. In addition to the types of imagery just mentioned, *E* makes use of a third, which is functionally closely related to the others, but apparently derives its origin from an entirely different sense modality. Imagery of a synaesthetic nature possessing color and carrying a strong emotional meaning is described as having "perceptual tangibility" with an unmistakable reference to the body.

For example, *E*'s number form consists of a vertical row of figures from one on up indefinitely. The figures appear in pencil upon a manila-colored background. Her alphabet form con-

sists of letters visualized along a horizontal line extending from left to right. The first 7 letters are identified with the 7 notes of a tonal octave. The imagery employed in these two forms is of an entirely different concrete nature, which has been derived from a direct visual stimulus. If there was ever any emotional synaesthesia connected with these forms, it has disappeared. In view of the facts, first, that the majority of *E*'s experiences are emotionally colored in a literal sense of the term, and secondly, that she uses these two forms constantly, we have every reason to believe that the lack of emotional coloring in these two cases is evidence of a very high degree of attenuation or mechanization. It is doubtful whether further simplification will take place, for everything contained in these two forms seems necessary for their use.

On the other hand, the coloration for days of the week and months of the year includes the curious tactual factor.

Sunday is a bright golden yellow—pleasing. Monday is a dull red with an intermingling of brown. Tuesday is a bluish-grey, sky-color like diluted copper-sulphate solution. Wednesday is a "soft" shade of brown like that of high-grade chocolate. Thursday is colored similar to Tuesday, but is more highly saturated. Friday consists of shades of red, blue and yellow. The colors are opaque and pigmented. Saturday is brown, like allspice, with a strong tint of yellow.

Sunday and Friday stand out in the form as being more emotional than the other days of the week. They are more highly colored, both in degree of saturation and in brightness. In other words, they represent more emotional experience than do the other and less colorful days. Perhaps they owe their imaginal coloration to some childhood experience which determined the synaesthetic processes, or the emotional value may have been added to the original synaesthesia, subsequently. However, we are compelled to favor the former view, because of the large number of instances in which the emotion determined the nature of the synaesthetic sensation and imagery, regardless of the nature of the stimulus.

The month form is a disc which is projected in space at a convenient reading distance. The months lie about the rim of the disc at regularly spaced intervals, one color merging into its neighbors. Beginning with January the months run counter-clockwise, with the new year falling at the position of half-past four. Thus, each month occupies about 30° of the disc.

January is made up of a "tactually compressible" dusty brown splotch, unpleasant. February is an opalescent, rosy orchid, flecked with white. It is utterly intangible, like vapor, and very pleasant. March is a dusty brown like January, but less saturated. Toward the end it becomes a tan color. The month possesses an internal whirling movement, also a slight degree of tangibility; mildly unpleasant. April is made of tangle reds, blues and purples, with the clear quality of spectral colors; pleasant. May has a green background, upon which are splotched bluish purple, whitish-

pink, red, and a very light yellow. The opalescent intangibility of April has nearly vanished; pleasant. June is a continuation of May, but lighter in color, with an addition of red and blue. The month is tangible. Strong mixed emotions. July is similar to June, with the exception that it is covered with a film of grimy, dirty brown. This color as well as the concept of July possesses a reference to bodily discomfort; strongly unpleasant. August is a continuation of July, with a marked increase in the July coloration and an increase in the bodily discomfort; strongly unpleasant. September is a background of dirty brown, splashed over with yellow and green; slightly unpleasant. October is a dark grey background, partially filled with shades of orange, yellow and red. The month possesses neither tangibility nor etherial opalescence; nominally neutral. November is a background of yellow, modified by the colors of October, less saturated; pleasant. December is predominantly a dark grey with a little blue, more white, and a small amount of intense blue-black; is in a magazine picture of midnight; pleasant.

In general our *S*'s month form is similar to those possessed by other synaesthetic individuals. It functions as a concept of a year's time, when perceived as a whole, and as different seasons when perceived in divisions. The segmented parts of the disc mean individual months. The individuality of the months depends upon their characteristic color and upon their proper place on the year-dial. Two additional factors enter into this form. First, the process of perceiving a synaesthetically colored month as an emotion,—by which we mean that the emotional response is represented in the various qualities of the colored imagery. Secondly, the process of perceiving a tactual tangibility or compressibility in the synaesthetic imagery. This is not an experience of that empathic variety in which a visual image appears as if it contained cutaneous sensations. Rather, the visual imagery means a tactual experience. It is, for *E*, tactual sensation. On the other hand, opalescent and etherial colors lack this tactual increment, and the experience as a whole contains the interpretative process that tangibility is impossible. This interpretation is traceable to the attentional emphasis upon the opalescent and etherial nature of the imagery.

The tactual and emotional elements are very closely related in that one color quality is common to them both. That is, the same appearance of the color-image that means opaqueness (visual signification) and tangibility (tactual signification) also means unpleasantness. Conversely, that appearance of the color-image perceived as opalescence (visual signification) and intangibility also means or functions as pleasantness. For example, the unpleasant months of January, July and August are tactually tangible, while the pleasant months (colors) of February, April, May and December lack the positive tactual quality and appear as intangible voids filled with nothing but opalescent coloring.

It is noticeable that the colors of green and dirty brown are generally included in the images of unpleasantness. Pleasant-

ness is included in the ephemeral colors of blue, red, and yellow. The less opaque and pigmented colors tend toward a neutral state, and give evidence of the same mechanization as was mentioned in connection with the alphabet form.

Olfactory perception. In these experiments various odors were presented to the *S* by means of a small, improvised olfactometer. Perfumes, ammonia, benzoate, formalin, ether, and other stimuli were used. Immediately after the presentation of the stimulus *E* described her perception introspectively.

Her olfactory perceptions consist first of a peculiar substitution of visualized, synaesthetic and emotional responses for the usual type of synaesthesia. It is impossible for her to perceive odors in terms of their own sensory qualities or in terms of stereotyped synaesthetic equivalents. A given odor is first perceived as a visualized emotional state. Then, during the course of the emotional synaesthesia, there is a disintegration into fragmentary concrete, visual and visual synaesthetic imagery which definitely relates the experience to some similar or identical experience in the past. It is from the imagery of the latter stage that the recognition of the odor is derived. The completion of the percept varies markedly, depending upon the degree of mechanization which has taken place through the influence of frequent experiences of like odors.

Thus, the first meaning to develop in the perception of an odor is pleasantness, unpleasantness, or a mild emotion. This meaning is a context of colored imagery. The context is then elaborated and differentiated as in ordinary perceiving, although the contents remain exclusively visual.

Failure to recognize depends not only upon the absence of associations, but also upon the circumstance that concrete imagery of these experiences is associated with an emotional response. Further, a recognition may fail because of an evident inhibiting of concrete visual imagery by unusually vivid and prolonged synaesthesia of the emotional response. That is, emotional coloration preempts the entire visual field.

E's responses to olfactory stimulation passed through certain characteristic stages of mechanization. Genetically the first reaction was emotional. This consisted of a color whose behavior and attributes meant that the stimulus was an odor and that the odor was pleasant or unpleasant. It served, therefore, not only as an undifferentiated perception, but also as an affection. As familiarity with the stimulus developed, the original emotion-colors diminished in intensity and internal movement, while the response became elaborated to include concrete visual imagery having to do with the place, the time, and other circumstances under which the stimulus was presented. But this concrete imagery was not affectively indifferent until mech-

anization was complete, *i. e.*, until the original coloration was all but gone. Meanwhile these concrete associations included not only their own synaesthetic colors, but also additional coloration of their own emotional hue. As a consequence, the relatively homogeneous color of the original emotional response became a mottled, heterogeneous massing of subdued tints. Therefore, the final stage in the mechanization process, where recognition was almost immediate, was at once affective and cognitive.

Typical Introspective Data to Illustrate the Above

Stimulus: refined ammonia. As the experimenter handed me the olfactometer I cautiously put it to my nostrils, because I had been warned to go slowly. First I was aware of a showering of sparks of electric-blue and copper, localized in the upper nostrils, which seemed to emit from the membrane. This experience first meant unpleasantness, and then pain. Immediately there developed, in the surrounding regions, memory visual imagery, still consisting in part of vivid and intensive blue and copper in the form of sparks, together with concrete visual imagery of the place and of myself in the act of smelling a bottle of ammonia. In this instance the original appearance of the sparks did not identify the ammonia, but with the appearance of the concrete visual imagery the experience became meaningful in a concrete sense. I cannot get beneath the meaning; it seems to be inherent in the experience and yet there is nothing to describe as content beyond the imagery, other than an observable something attending the imagery. This something is actually present but partakes more of an inference. It is a left-over. I cannot tell what it is. It is like trying to recall something when you almost have it and cannot clear it up.

Stimulus: rose perfume. Immediately upon the presentation of the stimulus a wealth of synaesthetic imagery developed consisting of numerous shades of pink, lavender, and a suggestion of light blue. This was the content of a feeling response of intense pleasure. This imagery had barely appeared when it began to fade, give way, but seemingly to clear up again in part, in terms of concrete visual imagery of pink, white and apricot-colored roses; I saw a large bouquet of white roses localized on a table before me—the table at which I was working a short time ago—then a bush of large pink roses seen against the house. This imagery was followed by snatches of apricot-roses seen hazily in their setting as I observed them on the way to the laboratory. All of this visual imagery came in very quickly and attention then slumped. The perfume had been perceived. Again the parent process was present, especially in the first part of the experience, but I cannot get at it. I know that there was something else there aside from the emotional coloring, but at the same time it seems as if it were not there.

Perception of sound. *E's* perception of single tones usually consists of a synaesthetic visual image which carries not only an auditory significance but also a distinct tactual meaning with some form of bodily reference. The brightness of the image is invariably dependent upon the pitch of the tone. The hue and degree of saturation of the color depend in varying degrees upon the timbre, intensity and manner of appearance of the tone, and always involve affective components. As in olfaction, therefore, synaesthetic images receive their color from

two general sources. This fact stands out all the more prominently in *E*'s responses to musical selections.

For example, the sound of a 5th octave C tuning fork is perceived in terms of visual imagery likened to a molten stream of glucose with the brightness, transparency and tactual consistency of glucose. The image is tridimensional and moves through space as long as the stimulus lasts. The two forks of 5th octave C and 4th octave G sounded together produce a single stream in which the two images behave like different currents intermingling without losing their identity. The higher note continues to be perceived as distinctly brighter, while the lower note is darker. In objective vision there occurs no analogous phenomenon to the telescoping process which *E*'s synaesthetic imagery undergoes. Beats appear as vibrations in the imagery, something like the elastic quiver of jelly. Behind all this synaesthetic imagery lurks the parent process.

It is possible to demonstrate both the effect of intensity and the effect of unpleasantness upon *E*'s auditory sensory reactions. For example, when the stimulus is steadily increased in intensity, the synaesthetic imagery of the experience will remain relatively constant up to the point at which the intensity itself produces unpleasantness. Then the synaesthetic imagery immediately takes on a different color, which carries both the meaning of unpleasantness and the meaning of an increase in the degree of intensity. Speaking in terms of the hedonic scale, the point at which the curve of affection begins to descend marks the instant at which the imagery becomes another color.

The visual synaesthesia of a mildly blown Quincke tube is described as a soft glow of brightness steadily increasing in size, fanshape, until the intensity causes the experience to become unpleasant. Then the coloring changes to a longitudinal, striated image, of poorly saturated, dirty brown. The color itself is the unpleasantness of the situation as well as the intensity of the tone, the emphasis depending upon *E*'s mental set at the time.

It would be interesting to know if the added emotion due to a rise in intensity depends upon proprioceptive stimulation. It appears as if this were the case, for, up to a certain point, the experience is a typical auditory-sensory one, characterized by the same mechanized combination of affective and primary, sensory coloration as we found in the case of olfaction. Beyond this point, added emotional coloration brings changes in meaning, and hereafter the emotional colors function both as auditory intensity signification and as emotion.

E's perception of musical selections consists of an elaborate amplification and combination of those processes which take place in the perception of single tones. A musical selection of any degree of complexity tends to become colored more and more by the emotion than by auditory factors. The whole is a blended, flowing stream of color which never ceases its movement as long as the music continues. The colors are projected out into space, where they are seen either upon or through the different external objects within *E*'s range of vision. It is diffi-

cult to describe this imagery of music, for it is changing from instant to instant, both in color and form. The change in form involves a peculiar variety of internal movement which is important in the problem of meaning and which gives mobility to the auditory consciousness.

Single instruments and solo voices produce much simpler synaesthetic patterns than do choruses and orchestral music. Below is given a series of abbreviated introspections which describe in a sketchy manner the imaginal content of short instrumental solos. The *S* was instructed to listen carefully to the music played to her on a phonograph, after which she dictated a complete introspection upon her experiences. Columbia demonstration records were used.

Violin: blues, yellows, rose shade of red; darker brown. All along molten, drawn-out mass with no break, dipping toward the lower tones and upward as the higher notes were played. Parent process.

Viola: reds, yellows, blues, more yellow and blue as the tones become higher in pitch, dipping the same as with the violin. Shades became darker as the lower notes were struck. Parent process.

Concert bass: so dark could hardly distinguish any colors. Looked like reds and greens in the twilight. Dipped slightly as in 1 and 2. In a few places, while the very lowest tones were played, the colors changed into midnight blue. Molten mass, only too thick to be stirred. Parent process.

Violin-pizzicato: fairies dressed in blue and yellow dancing on a green. The green, shadowy and somewhat colorless. The higher tones less color: these fairies had no feet or faces; were separated and distinct otherwise in form. Parent process.

String-quartet: so complicated and rapid in movement impossible to describe.

Harp: pastel shades of blue, yellow, red, and violet. They changed from one to another very rapidly, sometimes blending and sometimes contrasting; much of the time several colors were present at once; again several shades of the same color were present. The forms were rather intangible, like clouds; they changed so rapidly that there was no distinct form to any of the imagery; an ever-changing panorama of coloration. Parent process.

These introspections reveal a minimum amount of emotional coloring, for the imagery is greatly attenuated and the auditory origin predominates. The notes on violin-pizzicato illustrate a tendency on *E*'s part toward personification. Usually such a tendency consists of incomplete visual associations. In other cases, known to the experimenter, it has been observed that musical instruments produce reactions which in form and behavior appear like birds, animals and definite human individuals. Thus to one *S* the sound of a clarinet in the William Tell overture appears like an awkward wading bird of the stork-variety. Again, to another *S* the runs in Liszt's Second Hungarian Rhapsody are indefinitely personified as sober-faced, dignified old men running backward upstairs. At present we are making no attempt to explain the phenomenon or even to sug-

gest its function. However, we believe it to be an important factor in *E*'s consciousness.

Our *S*'s appreciation of music is much above the average, and is derived solely from the color-form and the behavior of her synaesthetic imagery. Three factors enter into the coloring of this imagery of musical selections. First, a mechanized color which is now dependent upon the sensory quality of the music itself; secondly, the color which is injected into the imagery by emotional states aroused by these synaesthetic experiences; and thirdly, the tactual reference which is incorporated both into the color and into the form of the visual imagery. It is difficult for *E* to analyze her appreciation of music sufficiently for us to ascertain the extent to which each one of these three factors determines the color and behavior of the imagery. In the greatly appreciated music the synaesthetic imagery never exists unmixed with emotional coloration. There occurs a point in the ascending scale of pleasantness at which the colored perception of the instruments as such changes over entirely into a synaesthetic reaction. It cannot be emphasized too strongly, however, that even here this new set of imagery functions as both perception of the music and as an emotional response to it. Usually there occurs some form of tactual reference in both the sensory and the emotional increment of the perception.

Introspective Data Illustrating the Three Different Factors

(1) Auditory factor. Stimulus: Hymn to the Sun; violin; Kreisler. The synaesthesia of the violin tones appeared as long, drawn-out, wavy festoons of red and yellow, moving over the visual field in a horizontal direction. The piano accompaniment appeared as drops of color tending toward a stone-blue. The latter were beneath the violin images in position. Small amount of emotional imagery present appearing in alterations, blendings, and obliterations of the separate piano and violin tones. (2) Emotional factor. Minuet in E; Beethoven. It was that delightfully pleasing music consisting of a full pouring-forth of color, tending toward ethereal reds, yellows and greens. Occasionally these colors were richly saturated. The colors were projected out into space in the form of vapours through which I had to look in order to see objects in actual vision. This selection was perceived entirely in terms of emotional synaesthesia; the sensory factor, as such, did not appear; there was no immediate consciousness of tones as such. (3) Tactual factor. Notes from introspection taken immediately after hearing a piano selection by a friend. The piano music appeared in a synaesthetic blue with a decided tactual reference, producing an experience similar to that of running the hand over a series of velvet tubes partially inflated with air. The tactual elements represent, in meaning, the quality of music, while the blue color is the pleasing personality of the player, determining the hue of the tones.

Illustrating the same phenomena in unpleasant auditory experience. Stimulus: Jazz orchestra made up of saxophone, banjo and piano. "The experience was decidedly unpleasant; the colors were made up of turkey reds of different shades, dirty greens, and metallic sparkles of blue and copper. This unpleasantness includes a reference to the body, perceived in terms of the scraping of rough metal across the forehead, sides of the head,

around to the back of the scalp and through to the surface of the brain. This bodily reference is not tactual as such, but an interpretation from the turkey-reds and greens. The experience contains a tactual signification—"the only immediate tactual experience I can describe; its content is color."

Objective vision produces an emotional synaesthetic phenomenon which corresponds very closely to that appearing in the perception of music. *E* affirms that most objective visual situations produce an accompanying color which is visualized as projected in front of, upon, or through and beyond the actual objects. These colors carry a definite emotional value of pleasantness or unpleasantness, delight or disgust. The like or dislike for objects, landscapes, *etc.*, is carried in the accompanying colors. This is best illustrated by the following quotation.

Notes on the change of coloration of a saxophone. "The boys who live in the second house from us have a jazz orchestra which always includes a saxophone. Its coloration was always a turkey red, orange, and bright blue mingled with a disagreeable shading of dirty greens and brown. Subsequently I became acquainted with the saxophone player whom I learned to like very much; he turned out to be an affable fellow with considerable personal charm. The next fall the jazz orchestra was again in full operation and I was surprised to find that the turkey reds, dirty greens and browns of the saxophone had now been modified by pastel shades with attending pleasantness. Later some boys were serenading in the neighborhood; the music did not fully awake me, but in a sort of dazed state I was conscious of tones which had the colors of a violin; this waked me still more and I listened attentively for some time, enjoying the quality of the music. I was greatly surprised to learn that it was this same boy with his saxophone. Ordinarily I should never confuse a violin with a saxophone. The confusion at this time seemed all the more unreal since I was perfectly familiar with violin and saxophone music played under similar circumstances."

If *E* happens to be looking at objects before her at the same time that she is listening to music, there frequently takes place a peculiar conflict or blending in the resulting emotional color reactions. Sometimes *E* finds herself trying to evade one conflicting emotional reaction in favor of the other. This is best illustrated in situations such as an opera or a motion-picture performance. In case the color produced by pleasantness or unpleasantness of the visual scene harmonizes with that produced in the perception of the accompanying music, the one enhances and amplifies not only the appearance of the other, but also the enjoyment and intensity of the other. When the reverse occurs, one set of colors tends to neutralize the other, both in saturation and in brightness. The same general laws of emotional coloration operate in the processes of amplification and neutralization as were found operating in the color scheme of the year form.

In summary, pleasantness as an accompaniment to vision consists of reds, blues and yellows, and as an accompaniment to audition of rose-reds, blues and brighter yellows. Unpleasant-

ness, as a visual accompaniment, consists of dirty browns and dull greens; as an auditory accompaniment it consists of dirty browns and less saturated, dead greens.

Auditory meanings in the perception of color. The content of our *S*'s perception of color has been studied very carefully with the purpose of isolating those factors which supplement the visual. Our procedure was to place a large sheet of colored paper in front of *E* with the instructions to describe minutely the color of the paper and any associated processes. Yellow, green, red, blue and green-yellow were used. Since several factors enter into *E*'s perception of objective color, it is impossible to discuss any one properly out of its relation to the entire process, although that is what seems necessary in analysis.

Upon the sensation of objective color *E* superimposes a considerable amount of synaesthetic imagery which functions as the meaningful part of the experience. This additional and supplementary imagery involves two factors: the sensory quality of the stimulus produces an emotional response which appears partly in the stimulus-color itself and partly in some additional color of synaesthetic origin, which is projected upon the objective stimulus. Incorporated within this perception of the color is the second factor, which consists of a stereotyped "association" with music. The experiencing of music, of course, is of auditory origin, and here there is no such auditory definiteness in the visual perception as there is in the tactual associations with music. It is possible, however, for *E* to judge the approximate pitch of this imaginal music from the degree of brightness in the stimulus-colors. The nature of the music derived from the stimulus-color depends upon the tint and degree of saturation. When fully described, this derived music is more like a memory of the music than the actual experience of hearing it. It is a musical experience in the absence of the parent process. *E* describes it as appearing static without internal movement within the image. Vitality is lacking in the rhythm, although the rhythmic striations appear in the imagery.

This point is illustrated by the following introspections. The Minuet, by Beethoven, was being played to the *S*. As soon as the synaesthetic coloration in her auditory perceptions was fairly well under way, the blindfold was lifted and she was confronted with a large sheet of violet paper. "The music aroused a wealth of apricot color, numerous tints of pink and lavender. Upon opening my eyes these colors were projected through and beyond the violet paper and my objective vision of the paper changed to a perception of a film-haze of violet color, which harmonized with the auditory, colored background."

Objective color, yellow: The objective color seems to fluctuate from the lighter tint to a darker tint; the latter was almost an apricot; the color as a whole produced a symphony of which the bright part of the yellow was the melody and the melody fluctuated from this to another produced by the darker, apricot tint. Neither melody was recognized as any particular selection, although both were orchestrations without indi-

visual instruments standing out. Both melodies were above the pitch of middle C, a judgment following from the brightness of the colors. This imagery is not auditory; it is synaesthetic visual imagery with auditory signification. The signification appears in the behavior of the visual forms. Their auditory meaning is present only when the experience is perceived as a whole; but it is very definite. On analysis it resolves itself into visual imagery.

Green: The green is made up of several shades which run to the lighter and darker tints. This color produces a musical meaning more unpleasant than the above; the key is below middle C; it was perceived as the voice of a Russian singer with a symphony playing off in the distance. The green quality meant Russian and the other shades made the accompaniment.

Again, in these musical experiences that accompany objective vision we find a tendency toward personification. An account of this phenomenon can best be made in terms of a reference to olfaction. Here it was found that the sensation itself, although synaesthetic, did not function as a recognition of the odor. It was necessary to continue the process until some definite imagery appeared with which the synaesthetic, emotional color could be associated. Then recognition appeared. Likewise in the perception of the violin-pizzicato, the fairies constituted a definitization of the perception process. It appears as a growth toward differentiation, *i. e.*, an elaboration of meaning. It turns out therefore, to be an emotional experience which is made objectively meaningful in the form of a perception. The musical experience derived from objective vision is an amplification of the visual perception. Objective color has in it visual qualities which are common to the visual synaesthesia of emotions experienced in auditory perceptions. This fact probably explains the close relationship between the two types of perceiving.

Cutaneous and kinaesthetic perceptions. Bodily sensations always appear in terms of visual synaesthetic imagery. The moderate and ordinary sensations are visualized upon the body only under a special *Aufgabe* to do so. When the experience reaches a certain degree of intensity it is recognized as pain, and the synaesthesia takes on an emotional color-process projected either upon the body or out in space. When the emotional color is present it serves either as emotion or as pain.

In one of our experiments the forearm of the *S* was anaesthetized by freezing with ether. Then there was applied to the anaesthetic area a stylus which was connected with an inductorium. Kinaesthetic sensations appeared as intense and streaked grey forms with a very little yellow in them. Further up on the arm the streaks fused; thus the individual muscles and tendons lost their localization. This imagery was visualized upon the forearm.

The anaesthetic area was permitted time to become sensitive and the intensity of the electric current was increased. Upon the second application of the stylus appeared a confusion of synaesthetic colors consisting of bright red, yellow and blue. These colors were mixed pain and emotion. Part of the time they were projected upon the forearm and part of the time out in space. These pain-emotions consisted of unusually bright and "glowing" colors.

Emotions proper. Emotional states as such exist as colors projected out in the visual field. The colors last as long as the emotional stimulus lasts, and the intensity and prevalence of the color are a measure of the intensity of the emotional reaction. It is possible for *E* to carry all day the color of an emotional state, while at other times the color will immediately fade. These hues range from dark shades to light tints superimposed upon objects in the environment, to colors so saturated and vivid as to obscure the visual field.

Illustrative introspections reduced to note form. Read of accidental death of a near neighbor; the newspaper suddenly turned green and took on a swirling motion; as I read the details the color faded somewhat but for several hours my imagery took on a greenish cast. Later in the day I picked up the American Magazine and discovered a reference to an old acquaintance. The green cast changed to colors characteristic of happier moods—rose, orchid and cream-yellow. . . . Upon learning one day in class that we were to be quizzed on a certain assignment my imagery became flooded with a washed out green and dirty-color, with flashes of turkey-red, bright blue, bright green, and pale orange, representing a mixed emotion of fear and a feeling of helplessness.

"I was rather tired, my imagery inclined to neutral gray. The experimenter was playing Beethoven's Minuet. While the resulting imagery was normal for that selection, it was rather subdued in shade. The colorings were blues, roses, apricots, lavenders and pinks. Then the experimenter blindfolded me while the selection continued, only to find, on seeing again, a sheet of very bright magenta color before me. Instantly for me the phonograph stopped playing, *i. e.*, the magenta color obscured the colors of the tones, as a result of which they lost their emotional value but retained their meaning as mere tone in terms of indifferently colored, moving forms. Colors changed to shades of sulphur, dirty brown, *etc.* Imagery meaning great distaste. The minuet was no longer a delight; pleasant shades of color were modified by distasteful ones."

Summary and Discussion

(1) In so far as this investigation relates to the previous work of Wheeler and Cutsforth, the present results are in entire accord with those obtained heretofore. Principal among them are the following. (a) The process of synaesthesia is distinctly a process of perceiving or of cognizing, the associated imagery of which plays the same rôle in synaesthetic *Ss* as in asynaesthetic *Ss*. The only difference in the perceptions of the two groups of individuals is the stereotyped and highly colored character of the secondary increment in synaesthetic individuals. (b) The associated colors provide the context necessary in the

development of meaning. Constituting a part of that context is a process which the *S* is unable to describe. Any attempt to define it results in a centering of attention upon some feature of the associated image. We have chosen to give the name "parent process" to this phenomenon. It seems to be that increment which, in asynaesthetic individuals, is referred to as an olfactory, auditory, cutaneous or kinaesthetic quality. Presumably it may be called sensation as such. Its presence and absence are noted in a total-perception of any given experience; but when this noting becomes at all specific the *S* finds that he is referring to internal movent or "vitality" of the experience. Beyond this, little can be said about it at present. (c) The absence of this parent process is one of the identifying features of synaesthetic, imaginal experiences as opposed to "objective" experiences. (d) In certain individuals at least, synaesthetic phenomena pervade the entire mental life. It so happens that this statement has been true of all cases studied intensively up to the present time.

(2) Our *S* is completely synaesthetic. Not only are the perceptions in all non-visual modalities characterized by the absence of non-modal qualities as such, but visual perceptions and visual images are also in part emotional in their interpretative stages. Synaesthesia runs not only into the use of visual imagery, but also into visual imagery whose significance is emotional and tactual. That is, visual perceptions contain color-imagery of a synaesthetic character.

(3) Within the limits of this investigation all of *E*'s mental processes, other than the highly mechanized, contain an emotional increment present in terms of color-imagery. This emotional increment is present in inverse ratio to the degree of mechanization of the mental process in question. Thus, mechanization and attenuation are characterized not only by the loss of form, position, internal movement and detail, but also by desaturation of the colors having emotional value. In other words, mechanization, in *E*'s case, involves the process of approaching indifference. This situation is analogous to the diminution of meaning which results, in asynaesthetic individuals, in an approach to the sensory level of experience.

(4) The same colors, under different interpretative mental sets, function as emotion, as tactual, or as auditory perceptions.

(5) The presence of emotional increments in *E*'s perceptual processes seems to hark back to emotional reactions of early childhood common to visual, auditory and tactual stimulations; and the common denominator, or medium of association between visual, auditory and tactual meanings now operative in *E*'s mental life, is color-imagery functioning as emotion.

(6) Particularly evident, as an example of this situation, is *E*'s tendency to associate melody with objective colors. These associations are not present in terms of auditory images but in terms of an ambiguous emotional synaesthesia. That is, the emotional coloration may refer to the objective color or to the auditory meaning, equally as well, depending upon mental set.

(7) This confusion, or what would seem to the asynaesthetic *S* to be a confusion, between feeling and intellectual processes shows how closely the two modes of response are related. Indeed, it seems evident that it is impossible to differentiate between the two except upon interpretative grounds. In *E*'s case generalized or undeveloped perceptions are always as emotional as they are cognitive. In case of a full-fledged perception which passes through observable stages of definitization or elaboration, the first stage of development is a feeling process whose imagery becomes modified and elaborated as the perception becomes concrete and the object is identified.

In *E*'s case, therefore, emotion and cognition are not to be described by differences in content but by differences in attitude. The two modes of response are not to be contrasted in terms of aspects. The difference is a derived phenomenon, representing two successive stages in the course of development of a perceptual process. Neither the emotional nor the so-called cognitive stage of a perception is a matter of immediate experience; *i. e.*, they are not existential but interpretative phenomena. We are inclined to suspect that these facts are equally true of all individuals.

(8) Our results seem to throw light upon the problem of the stimulus or meaning-error. Tactual, auditory and emotional factors in *E*'s mental life, existing alone or in mixtures, are distinctly meaning phenomena, unanalysable except in terms of meaning, whose only observable content is visual. Tactual, auditory or emotional significance appears only in a total and complex experience; it is a characteristic of the complex as such, not something which can be reduced, adequately, to single contents of a sensory character. We are not here promoting the theory of imageless meanings, but we are inclined to believe that meanings are in themselves contents, deriving their structural character from synthesis. This explains why, when perceived as a whole, a certain experience possesses a definite tactual or auditory meaning; but, when analysed into its ingredients, loses its original character and becomes nothing but visual imagery. The difference between the synthetized and the analysed state is to be explained in terms of mental set. In other words, the problem is a functional one. The logical conclusion from this, of course, is the view that every experience

contains an irreducible increment—the meaning quality prior to analysis; and that no experience, however simple, exists in the absence of this functional phenomenon. In other words, as defined by conventional psychology, there is a meaning-error in every mental process. This is no other than the interpretative factor characteristic of every perception.

(9) It would seem that in *E*'s case visual perceptions involve a parent process. The redness, yellowness, greenness, *etc.*, are in reality such parent processes camouflaged, as it were, by mechanized associations of long standing, and simplified to such an extent that the awareness of color seems to be an elemental experience. But on more careful analysis this elementary character of the experience turns out to be a meaning-phenomenon and therefore complex. The ordinary *S* finds hue, saturation, brightness in his visual reactions so immediately as to lose the associative processes by means of which these colors become a phenomenon of awareness. On the other hand *E* brings such apparently extraneous associations to bear upon her objective vision as musical meanings whose contents are visual, synaesthetic images. These associations are so definite as to make possible judgments of pitch. It is a curious fact that these auditory associations are not auditory in content, for auditory processes, both sensory and imaginal, are visually synaesthetic. Hence auditory perceptions, both of direct and indirect character (by way of auditory stimulation or round-about association), are meanings whose content is visual. So far as we have been able to determine, where such auditory or emotional associations are not present, *E*'s consciousness of color is vague and indescribable.

(10) We may ask the question, why does our *S* insist upon describing so many of her experiences in terms of emotional coloration? Why can they not be described simply in terms of brightness and color qualities? Obviously for the simple and ample reason that it is impossible; for without this emotional reference the experience ceases to exist. To inhibit the emotional significance means to alter the total experience in such fashion as to make an entirely different sort of thing out of it. The same thing is true for the tactual increment in *E*'s perceptual processes. *E* is utterly helpless in attempting to describe this tactual experience in any other terms than meaning. Opalescence and etherialness are as much attributes, for her, apparently, as granularness, arealness or what not are for the conventional laboratory *S*. Attributes are seemingly indeterminate in a last analysis.

(11) Foremost in *E*'s mental life is the process of interpreting. This is functionally elemental and depends upon the circumstance that the simplest possible experience is a complex.

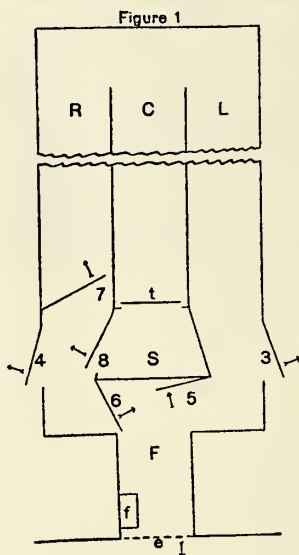
Introspectively it is impossible to get beneath the percept with its interpretative factor. It seems to the writer that this fact has not been taken into account sufficiently in systematic discussions.

(12) The rôle of emotion in *E*'s mental life is twofold. First, it functions in undeveloped perceptions, and secondly, as the end-stage in elaborate recognition processes. Consequently, in a certain proportion of her memory processes, where mechanization has reached its limit, emotional coloration has all but disappeared. In the remainder of her recalls the emotional content, in terms of synaesthetic colors, remains in varying amounts up to complete predominance. In her case, of course, emotional experiences as such are recalled definitely in terms of visual images. We have come to the conclusion that, in a last analysis, feeling processes are undifferentiated cognitive processes, *i. e.*, perceptions in which either a labelling or identification process fails to mature, and that this fact holds for asynaesthetic individuals as well. It would seem that in ordinary laboratory investigations of feeling, *Ss* have looked for contents whose characteristics and behavior show marked differences from the so-called perceptual reactions. In the light of our results it is evident that, before we can be certain of our psychology of feeling, a great deal more careful experimentation will be necessary, in which more regard is paid to the factor of interpretation in mental life.

THE BEHAVIOR OF SHEEP AND GOATS IN LEARNING A SIMPLE MAZE

By HOWARD S. LIDDELL, Physiological Field Station, Cornell University

In the course of an investigation concerning the effect of thyroidectomy on the higher activities of the nervous system a simple maze was constructed which can be learned by sheep and goats and by means of which it is possible to study habit formation in these animals following the extirpation of the thyroid glands. The ground plan of this maze is shown in Fig. 1. A detailed description is to be found in a previous article (1).



It consists of an enclosure 67 ft. in length and 10 ft. wide covered with cinders and surrounded by a board fence. One end of the maze joins the barn, in the second story of which is the observation window covered with fine wire mesh. There are wire netting partitions between the three parallel alleys. The sheep or goat to be tested is confined in the starting compartment S. When the door t falls the animal emerges and, impelled by the gregarious instinct and usually by desire for food as well, finds its way down the alley C. Either outer alley, L or R, may be made a cul-de-sac by closing gate 5 or 6. The animal must learn to avoid the blind alley and to go up the open alley to the feeding compartment F where it can see the flock in the barn through the screen door e. Learning is judged complete when it makes three successive direct trips through the maze.

A number of cretinoid sheep and goats have already succeeded in learning the labyrinth; but in this paper only the behavior of normal sheep and goats will be considered. Three groups of sheep have learned the simple maze: first, 11 lambs from two to three weeks of age tested during May and June 1921; second, 17 May lambs tested in July and August 1922 at about two and one half months of age; and third, a group of 18 May lambs of the same year and procured from the same flock, tested in December 1922 at about six months of age.

Analysis of the behavior of the lambs in learning the simple maze. The behavior of each animal exhibited certain characteristic features which determined, to a varying extent, its pro-

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